How a magnet physically attracts another from a distance

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Abstract

There is a set of properties that a theory must address in order to explain the magical, invisible, action-at-a-distance phenomenon of attraction and repulsion between two magnets. Here we show that of the entities proposed to date only the Rope Hypothesis can physically simulate all of them.

Keywords - wave, wave-packet, particle, action-at-a-distance, light, magnetism, electricity, field, object, electromagnetism, Rope Hypothesis, Thread Theory

I. Abstract Physics

The magnetic, action-at-a-distance properties of lodestone have been known at least since Ancient Greece, but to this day theorists have yet to identify a mediator for magnetism. What mysterious physical object or objects operate in the region known as 'magnetic field'? What are the 'lines of force' along which iron filings align in a magnetic field? How does either of these two 'entities' mediate attraction and repulsion between two magnets?

There are those who would argue that no mediator is necessary to understand what is occurring between two magnets or, for that matter, in any other physical interaction. Maxwell was one who argued that *heat* can be transferred because, although *heat* is not a substance, it is no different than *mechanical work* and is, therefore, a form of *energy* that can be treated mathematically as a measurable quantity. [1] Maxwell was able to make such a baseless statement because he never defined the strategic word *object* without which Physics cannot be done. The fact that parameters such as *work* and *energy* can be measured and placed in an equation does not convert them into objects. Quite the contrary! Any parameter that can be placed in an equation is by definition a concept. There are no equations with parameters such as rock, tree, or atom. For the purposes of Physics, an object is *that which has shape*. [2] If work and energy cannot be imagined to have shape, this instantly takes these two words out of the list of objects and places them squarely in the list of concepts.

The Golden Principle of Physics demands that the actor in all transactions be an object. [2] We cannot do Physics without an object. This principle is inviolable and non-negotiable. Any suggestion that physical phenomena such as gravity, light, electricity, heat, and magnetism can dispense with mediators tacitly introduces spirits in that space. It does not follow that because we cannot see the entities operating in a region around a magnet that there is nothing there. If sight were a criterion for objects, the air we breathe and the atoms of which we are made would cease to be. It is not the mind, but rather the eyes which must be tapped to 'see' invisible entities. A theory is a movie. The theorist should place the images he envisions in every frame of his film. Every facet of electricity and magnetism must be explained with objects. What will the audience see on the screen if the theorist has not placed images between two magnets in any of the frames of the film?

A theorist attempting to rationally explain magnetic attraction and repulsion must, in addition, make provisions for a series of related phenomena that conduce to the explanation of magnets. Experience tells us that a magnetic 'field' already surrounds a live wire before we do anything with it. Coiling the wire generates a force through its center. And two parallel live wires attract or repel depending on the direction of the 'current'. These phenomena must be included in any comprehensive theory of how a magnet works.

II. Explain vs. Describe

Many self-styled 'physicists' falsely advertise in their sites and videos that they can *explain* 'how' a magnet attracts another. [3] When inspected up closely, however, the *hows* and *whys* of Mathematics are shown for what they are: *descriptions*. The 'hows' of Mathematical Physics have to do with *describing* what the magician did on stage: "He sawed the lady in two pieces with 20 strokes in 10 seconds. Later, the girl appeared in one piece and bowed to the crowd." This

notion of 'what happened' differs radically from the *hows* and *whys* of Physics which seek to explain the hidden mechanism behind the trick. It is rather superfluous to say that gravity always pulls a pen to the floor (description). A physicist is interested in explaining the invisible mechanism Mother Nature uses to accomplish such a feat.

With respect to magnetism, this confusion between *description* and *explanation* dates at least as far back to the 13th Century when experimentalist Peter Peregrinus boasted that he could 'explain' the mechanism that draws two magnets together. Peregrinus wrote that north attracts south and that like poles repel, not realizing that all he did was describe what he observed.[4] We could just as well have called the ends of a magnet heads and tails and learned just as much.

Three hundred years later, Gilbert merely transcribed Peregrinus' 'theory' and added a mystical 'effluvium' to the description: an invisible vapor allegedly emanated by the magnets.[5] Even if we were to concede Gilbert's vapor for the sake of argument, how does the fact that two magnets that emit this spirit bring them together? What is the physical mechanism?

The successors of Peregrinus and Gilbert did little better. Here are a couple of present-day examples from those who, following the paths of Peregrinus and Gilbert, assert that they have 'explained' how a magnet does its magic:

> *"Magnetism is generally thought of as a current, a flow of electrons, but which have an electric field which induces a magnetic field through… electromagnetism… There's a current flowing in the magnetic material… In the Earth… we have somehow a spinning, giant mass… of molten iron which carries a lot of electrons, which are in motion which induce a current which creates a magnetic field"*[6]

> *"We have two magnets here. Each one has a north and a south end. We place this magnet here and let's watch what happens when I move this one in. Attraction! That's north and south. We flip it around and what happens is we see repulsion because north is not going to attract north and south is not going to attract the south…*
> *…the reason for this is because we have a magnetic field and within this magnetic field we have atoms and we have a bunch of electrons in these atoms and they're just pretty hyperactive and they're creating this activity which is giving us this attraction and repulsion"*[7]

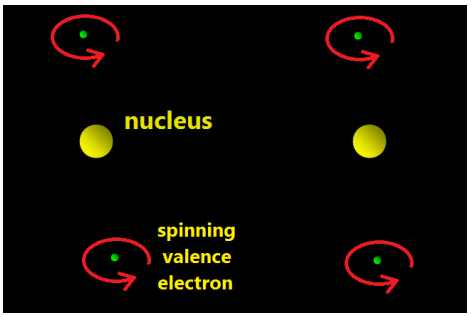
> *"It was discovered that electrons had a property called spin, that is, the electron was spinning as it circled the nucleus. It's the alignment in these electron spins that results in the magnetic properties of iron… In summary, a magnet is a collection of microscopic crystal domains that have their electron spins aligned."*[8]

To state robotically that north attracts south or that electrons have their spins aligned or that a magnetic field is created around moving charges does not disclose the physical mechanism underlying attraction. For instance, we need no Math or abstract concepts to understand why the donkey's head is jerked forward by a farmer tugging on a rope tied to the animal's neck. In what way does the fact that two electrons have their spins aligned physically result in one magnet being pulled towards the other from a distance (*Fig. 1*)?

Fig. 1 Electron spin produces attraction/repulsion?

Following the specifications of the UCLA Physics Department, we have two atoms, each with their valence electron spins aligned. Now, how do these spinning electrons tug on the electrons of the other atom? By what physical mechanism?

What Quantum Mechanics will NEVER be able to explain rationally is action-at-a-distance (e.g., entanglement) with discrete particles and no physical mediator between them! The proponent is in effect introducing spirits in that space and magic in his theory!



Assuming we concede electron spin in the foregoing quotes, these amount to nothing more than descriptions. The theorist is stating that when two magnets attract each other he realizes or observes or measures that the electrons spin in a given direction. We have yet no idea how two electrons with aligned spins tug on each other from afar. Yet theorists incongruously label such descriptions as explanations and are satisfied that they have revealed Mother Nature's secret mechanisms.

Here we will attempt to give a physical interpretation – a genuine explanation – to the most outstanding electromagnetic (EM) questions investigated since the 19th Century and which remain unanswered by the mathematical establishment to this day. We will simulate these properties with the Rope Model of light and compare the explanations against the theories proposed by orthodoxy.

III. INEXISTENT LINES OF FORCE

In the mid-19th Century, Faraday wrote that the magnetic field was comprised of what he called 'lines of force' and which he believed to be real. He wrote:

> *"I cannot conceive curved lines of force without the conditions of a physical existence in that intermediate space."* [9]

He was able to distinguish the lines by sprinkling iron filings on a magnet, an experiment still imitated in the classroom by elementary and high schoolers today. Despite Faraday's strong hunch that these lines were real, hard as he tried, he was unable to break the code or to convince his co-religionaries.

Maxwell dismissed the physicality of Faraday's lines and limited his analysis to expressing the field mathematically. [10] His authority was and still is so overwhelming that even today theorists continue to repeat the mantra that a 'line of force' is nothing more than a convenient representation: a way of *describing* how the iron filings align…

> *"…these lines are not physical lines that are actually present at certain locations; they are merely visualization tools… field lines are a 'mere' mathematical construction"* [11]

> *"lines are used to represent the force existing in the area surrounding a magnet. These lines, called MAGNETIC LINES OF FORCE, do not actually exist but are imaginary lines used to illustrate and describe the pattern of the magnetic field."* [12]

Maxwell and those that followed in his footsteps are in essence proposing that metal scraps align along these lines for no reason whatsoever. There is no physical entity moving them there. There is no physical cause behind this phenomenon. It just happens.

And then again, the popular site 'How Stuff Works' has one of its professionals write:

> "*Like poles repel each other because their lines of force are traveling in opposite directions, clashing with each other…"* [13]

Clashing lines of force? Wasn't the argument that lines of force were just mathematical abstractions? Weren't they 'just' representations to help us visualize and describe? How can concepts clash?

Unfortunately, we must be blunt with Maxwell and his successors on this non-negotiable point – offend whom it may offend. The Golden Principle of Physics stands firmly in their way: He who does Physics with concepts or proposes that no object is present in the region where a phenomenon occurs is summarily filling in the blanks with ethereal spirits. [2] Such a theorist is outside the bounds of Physics and rationality. No more needs to be said.

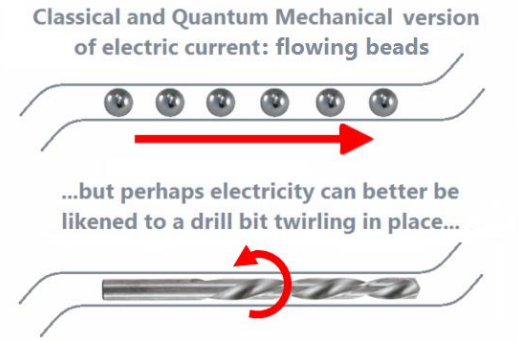
But then, if these lines of force comprising the magnetic field are real and physical as Faraday suspected, what are they? How can they be invisible and inexistent yet be able to have an effect on comparatively heavy, visible iron filings? And what is this invisible, magical aura we call 'field' which apparently is filled with these lines? The chilling, mystical magnetic spirit is definitely a one-way ghost: it touches you, but you can't touch it. The ghost walks up the stairs, pushing its foot against each step, but then melts through a wall like a hot knife through butter. How can a 'field' have such irreconcilable and magical properties?

IV. FLOWING BEADS

As early as 1827, Ampere wrote that two parallel live wires first came together and then repelled each other when he changed the direction of one of them. [18] The theory still in vogue to explain this phenomenon is that attraction and repulsion have to do with the direction in which current flows.

Let's first draw attention to the fact that Ampere's description rests heavily on the assumption that electricity consists of discrete electron beads compelled to flow through the rows of atoms that constitute the wire. Ever since researchers and theorists began to tinker with electricity they did none other than take for granted that electric current consists of bullets. [14] [15] [16] [17] [18] [19] [20] [21] [22] It never occurred to anyone from the 18th to the 21st Centuries that perhaps nothing is moving from one end of the wire to the other, but that maybe electricity can better be likened to a drill bit twirling in place (*Fig. 2*).

Fig. 2 An alternative way of visualizing electricity



Ampere's still unchallenged notion that beads roll along a wire from one end to the other is quite perplexing in light of the fact that Eddy currents swirl helically through a wire subjected to magnetic influence. What is it about a magnetic field that could possibly induce such spiraling behavior in each of the electron beads? What physical object, what surface comes in contact with each electron bead to compel

it to behave in this manner? This is not a question of Mathematics, but of Physics.

In a related phenomenon, Mathematical Physics invokes the abstract and undefined mathematical concept *field* to 'explain' how discrete electron beads in one wire affect those of the other through the intervening space. This theory proposes that the magnetic field of one wire influences the magnetic field of the other:

> *"One wire sets up a magnetic field that influences the other wire, and vice versa. When the current goes the same way in the two wires, the force is attractive. When the currents go opposite ways, the force is repulsive."* [23]

> *"If two current carrying wires are parallel to each other, their respective magnetic fields either attract or repel each other… if two parallel wires have currents traveling in opposite directions, the magnetic fields generated by those currents between the wires will both point in the same direction… These wires would repel each other… if two parallel wires have currents traveling in the same direction, the magnetic fields generated by those currents between the wires will both point in opposite directions resulting in the wires attracting each other."* [24]

There is not even a hint in such descriptions as to how the magnetic spirit known as 'field' accomplishes such a feat. In order to even get close to what mathematicians propose, we need to zero in on the meaning of the enigmatic term 'magnetic field'.

The Random House Dictionary defines the term 'magnetic field' as: *a region of space near a magnet, electric current, or moving charged particle in which a magnetic force acts on any other magnet, electric current, or moving charged particle.* [25] The Encyclopedia Britannica is more or less in agreement: *region in the neighbourhood of a magnet, electric current, or changing electric field, in which magnetic forces are observable*. [26] These notions have not changed much since Faraday coined the term *field* in the 19th Century, using it at least as early as 1845 in his published papers. He defined a *magnetic field* as *"any portion of space traversed by lines of magnetic power"*. [27] Coming on his heels, Maxwell defined *field* as *"the space in the neighbourhood of the electric and magnetic bodies… in that space there is matter in motion"*.[28] And a contemporary Internet school teaches its students what Faraday and Maxwell passed along:

> *"We understand that magnets have two poles and that depending on the orientation of two magnets there can be attraction (opposite poles) or repulsion (similar poles). We recognize that there is some region extending around a magnet where this happens. The magnetic field describes this region."* [29]

Therefore, there is no disagreement between what is being taught in the classroom today and what the founders of the theories concocted 150 years ago.

In short, a *field* is not a standalone physical object, but rather a 'region' where something *occurs*. A region is always an area or volume of something else. Therefore, whenever we see the word *field*, we need only substitute it with the word *region*.

However, in Physics, it is but awkward, certainly bordering on irrational, to say that a concept such as a *region* compels physical objects such as iron filings to move or that a *region* attracts another region, a wire, or the electron beads of another wire. The use of the abstract concept *region* as a physical baseball bat is outside the purview of Physics.

The ball is in the 'field' theorist's side of the court. The proponent of *field* has the option to present *field* as a standalone object that mediates electromagnetic phenomena or not use the word at all. There is a single way to present a standalone object in Physics and that is to illustrate it. [2]

And for those die-hard mathematicians who dismiss these as 'semantic' or 'philosophical' arguments, Science replies that 'semantics' is what a person who uses the word *field* as a physical object does. A physicist has the obligation to place images of objects in each frame of the film so that the audience can visualize what role they play in the mechanism he proposes. If instead the word *field* is introduced as a concept, the theorist has no alternative but to define the term. Any attempt to avoid both options on grounds that the request amounts to 'petty semantics' or to a 'philosophical issue' reflects on the snake oil peddler, not on his customers. It exposes his true colors.

V. THE PROBLEM

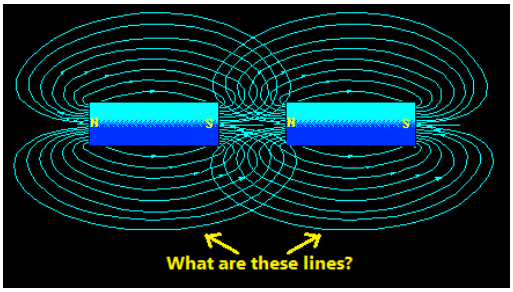
What is the issue before us?

The issue before us is that we have two chunks of metal known as *magnets*; that's the entire system. It is one of the simplest systems we can imagine: just two strips of metal. They have the magical ability to attract and repel each other depending on the direction they're facing. We want to explain by what physical means one magnet attracts and repels another. It is a simple question. The answer to this question, however, has eluded the greatest minds in history.[30] The sages of every university and research institution in the world today still cannot provide a physical interpretation to what is happening before their very eyes.

Do we need Math to solve this problem? Or do we need to figure out and make an assumption about the invisible object(s) serving as mediator(s) in the space between the magnets? The Golden Principle of Physics directs you to go with the latter option (*Fig. 3*). It is absolutely essential to make visible the invisible objects that are operating between the magnets to simulate the magical behaviors and effects we

observe in the lab if we are ever to explain and understand this simple phenomenon.

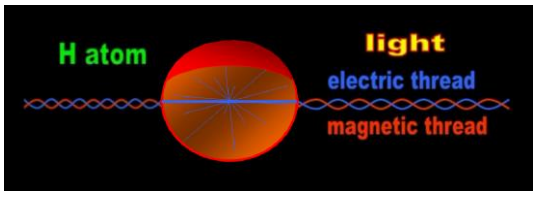
Fig. 3 Make the invisible visible



VI. THE ROPE MODEL OF THE ATOM

Under the Rope Hypothesis, the lines of force that Faraday discovered are the threads that comprise the electro-magnetic rope (EM Rope).[31 32 33 34] Briefly, the EM Rope is comprised of two twined threads that extend from one hydrogen atom to another. *(For simplicity's sake, we simulate all explanations with H-atoms.)* The electric thread (E-thread) continues straight to the center of the atom and out the other end. Countless E-threads extending from every atom in the Universe converge upon the center of the atom forming a star-like dandelion known as the proton. A magnetic thread (M-thread) forks at the boundary of the atom and coils around it. Countless M-threads extending from every atom in existence weave the electron shell or balloon that encapsulates the proton star (*Fig. 4*). This is the basic model which we will use to explain electromagnetic phenomena.

Fig. 4 The EM Rope Model of the Atom and Light



In contrast to the discrete Particle Hypothesis of Quantum Mechanics, the Rope Model proposes that all atoms in the Universe are interconnected by DNA-like EM Ropes (*Fig. 5*). This entails that any two atoms are bound by a pair of twined threads: a single EM rope (*Fig. 6*). Indeed, as a side issue, Thread Theory suggests that the DNA molecule as well as the most common organic compounds on Earth – for instance, collagen and cellulose – imitated the elongated strand structure of the EM Rope. The proposal that matter is interconnected leads to radically different theories and conclusions regarding the nature of matter and the workings of the Universe.

Fig. 5 Quantum discreteness vs. Rope interconnectedness

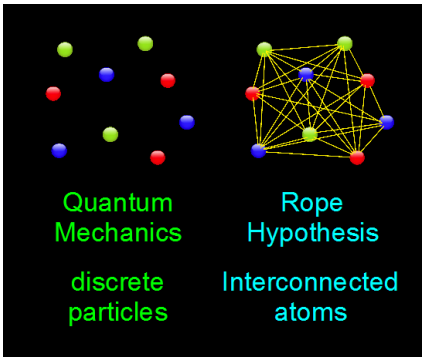
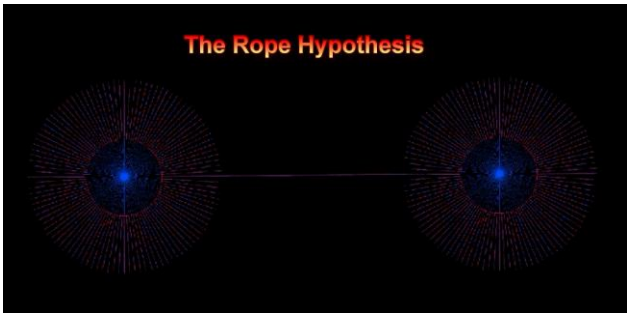


Fig. 6 Two atoms bound by the EM rope



Under the Rope Model, a magnetic field results when two atoms are induced to spin at high speeds. The rope releases one of the threads which instantly swings around the other (*Fig. 7A*). A row of aligned atoms spins and swings threads around itself (*Fig. 7B*). It is this wall of swinging threads that constitutes the magnetic field.

Similarly, *electricity* does not consist of the flow of electron beads from one end of the wire to the other as it is in Classical and Quantum Mechanics. Electricity consists of a spinning row of aligned atoms and can be likened to a drill bit spinning *in situ* (*Fig. 8*). Consistent with the left-hand rule, the direction of the 'current' is parallel to the row of atoms and perpendicular to the direction in which the threads are swinging (i.e., the magnetic field).

In order to explain what Ampere discovered – wires attracting and repelling depending on the direction of current – it is worthwhile first to:

a. visualize the pattern left by iron filings around two 'current carrying' wires in both same and opposite directions.

b. visualize the mechanisms of attraction and repulsion through an analogy.

Fig. 7 When two atoms are stimulated and spin at high speeds, a thread breaks free from the EM rope. It then begins to swing around the other (A). A row of aligned atoms (serpentine) swings countless threads around itself (B). It is this wall of threads that constitutes the magnetic 'field' of Mathematics.

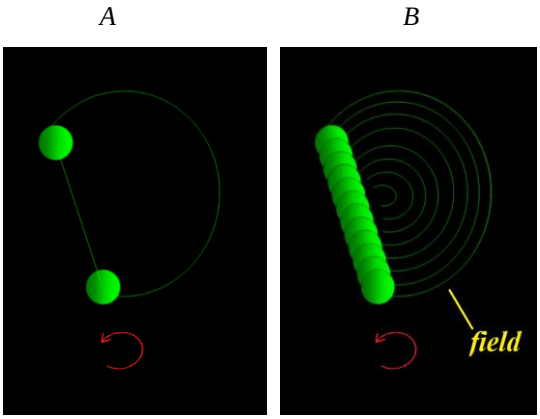
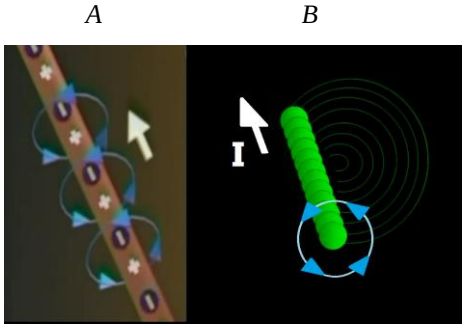


Fig. 8 Electric 'current'

Conventional left-hand rule has abstract 'negative charges' (a mathematical concept) 'flowing' along the wire (A). Under the Rope Model, the physical serpentine spins in situ like a drill bit (B). Consistent with experience, the wall of threads (magnetic field) swings perpendicular to the direction of 'current'.



VII. PATTERNS OF ATTRACTION AND REPULSION

The case of attraction. In *Fig. 9A* we illustrate the pattern left by iron filings sprinkled around two wires that have 'current running' in the same direction (i.e., the wires attract each other).

We identify three regions (*Fig. 9B*):

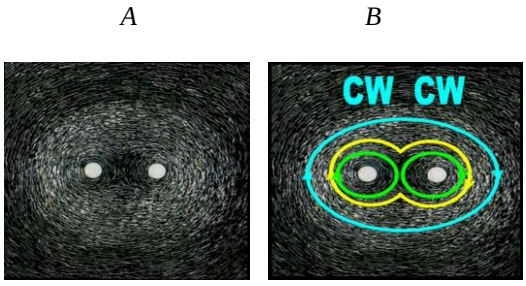
1. A circular inner region where the filings surround each wire (green line).

2. A figure-8 region of iron filings that do not complete a circle. It is as if a given iron filing tried to go around one wire and was intercepted by something and redirected around the other wire (yellow line).

3. An oval-shaped region that surrounds both magnets.

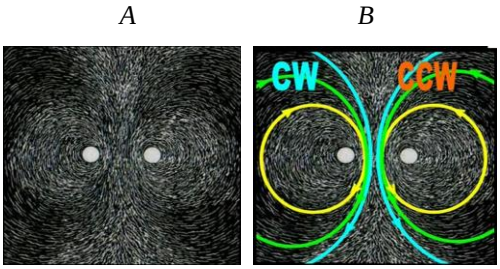
Of course, the iron filings are not going anywhere. This pattern is better explained as the circling of countless walls of threads (lines of force) right through the iron filings and moving them into position through friction between the threads and the atoms that constitute the iron filings. The inner threads swing in circles around the first wire up the boundary where they meet threads from the other wire. It is at this point where they interfere with the next set of threads which are circling the other wire and together they induce the figure-8 pattern on the iron filings. The last set of threads has no chance to enter in the first two regions because the density is too high. Therefore, the threads swinging in this region end up circling both wires.

Fig. 9 Attraction: pattern left by iron filings sprinkled around two wires 'carrying current' in the same direction.



The case of repulsion. Fig. *10A* depicts the pattern left by iron filings sprinkled around two wires that have 'current running' in opposite directions (i.e., the wires repel each other). The iron filings appear to circle each wire forming an ever growing oval the greater the distance they are located from each wire (*Fig. 10B*). Between the wires, it is as if they are forced to squeeze through a narrow opening to allow the iron filings circling the other wire to go through as well. The entire pattern looks like an old, manual, two-roller washing machine squeezing water out a shirt. Of course, it is not the iron filings which move. They merely align along the paths of sweeping threads that are swinging at high speeds around each wire. The spinning threads move the iron filings into position against each other and then keep them there. These rows of aligned iron filings are what Faraday identified as 'lines of force'.

Fig 10 Repulsion: pattern left by iron filings sprinkled around two wires 'carrying current' in opposite directions.

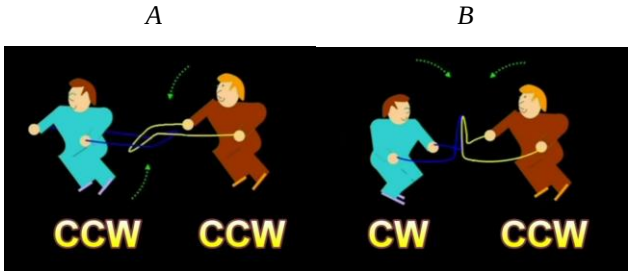


VIII. VISUALIZING THE MECHANISMS OF ATTRACTION AND REPULSION VIA A SIMPLE ANALOGY

The mechanism of attraction. There are two brothers Axel and Rod skipping ropes next to each other. They both face the same way and swing their respective ropes counter clockwise (CCW) from your vantage point. As the rope of Axel comes up it snags Rod's rope which is coming down (*Fig. 11A*).

The mechanism of repulsion. Now Axel turns around, faces his brother, and swings his rope clockwise (CW). The ropes clash and push each other away (*Fig. 11B*).

Fig. 11 The physical mechanisms that underlie attraction (A) and repulsion (B) under the Rope Hypothesis



IX. HOW A WIRE ATTRACTS/REPULSES ANOTHER

Let's now extrapolate these mechanisms and patterns to Ampere's parallel wires. For simplicity's sake, we will assume that each cable consists of a single serpentine (i.e., a single row of atoms).

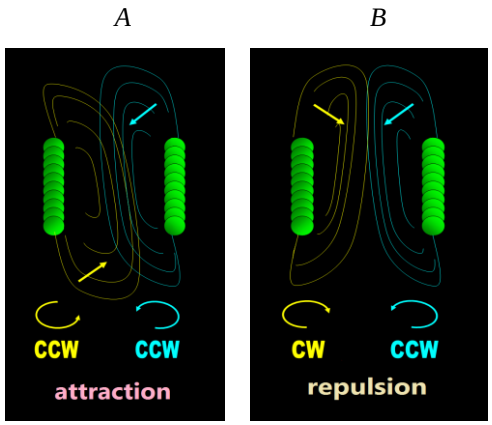
In cables that run current in the same direction, the Rope Hypothesis proposes that the serpentines are both spinning CCW from our perspective and swinging countless threads around themselves. As the threads of the serpentine on the left (yellow) come up they interfere with the threads of the serpentine on the right (blue) which are coming down (*Fig. 12A*). The effect is a tug and the two wires come closer to each other. The closer the wires are to each other, the more threads that intervene in the process and the faster the wires approach each other.

If we turn the left wire around so that the serpentine now spins CW, the walls of threads of the two wires collide and push each other away (*Fig. 12B*). The closer the wires are to each other, the more threads that intervene and the stronger is the force of repulsion. As the wires move farther apart fewer threads intervene in the action and the repulsive force weakens.

In a real life situation, there is not just one wall of threads extending from one wire but thousands of layers of threads. There is one rope connecting any set of two atoms! The entire region known as 'magnetic field' is scanned by threads swinging around and going *through* air, water, paper, or any other material placed in their paths, most notably iron filings sprinkled upon it.

Fig. 12 How live wires attract and repel

Two live wires in parallel attract each other if the respective serpentines swing the threads in the same direction (A). If we turn one of the wires 180°, the walls of threads clash and the wires push each other away (B).



X. A COILED WIRE IS A MAGNET

In *Fig. 13* we illustrate the direction of the field when the wire is curved into a U-shape. Consistent with the left-hand rule the fingers end up facing in opposite directions (CW vs CCW) when the hand is on the opposite side of the coil.

Under the Rope Model, the threads of a straight live wire swing in the same direction as shown earlier in *Figs. 7B* and *8B*. Curving the cable into a U-shape results in threads facing each other on opposite sides of the coil: CW vs CCW (*Fig. 14*). Note that the threads on all sides push through the center of the U in the same direction (yellow arrow). This is what is known in Mathematical Physics as electromagnetic force.

If we continue curving the cable we form a coil or solenoid. As one would expect, the threads push through the

center of the coil in the same direction (i.e., the electro-magnetic force) (*Fig 15*).

It is a common experience that a coil is simply another configuration of a magnet (*Fig. 16*). The fields that surround each loop in the coil (2) blend to form a single field (3) that travels in opposite directions (CW vs. CCW) (4) to the field surrounding the opposite side of the coil (5). This exactly matches the flow of the lines of force in a magnet (6).

Therefore, we can safely superimpose a live coiled wire on a magnet and match the patterns (*Fig. 17*). The threads (lines of force) swinging around each loop of the coil blend as shown in *Figs. 9B* and *10B* and form a single 'field' that circles the entire coil in opposite directions (CW vs. CCW) on opposite sides of the coil. Predictably, all the threads push through the center of the coil (i.e., EM force).

Fig. 13 Direction of the field in a wire coiled into a U-shape. The fingers end up facing each other (CW vs. CCW) on opposite sides of the coil.

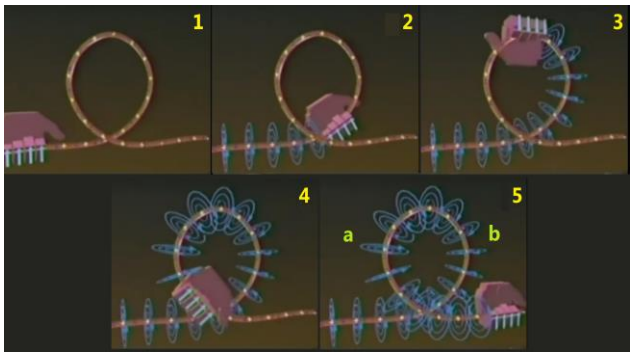


Fig. 14 Rope Model version of a coiled wire

Threads on opposite sides swing in opposite directions. All the threads push through the center of the coil (EM force).

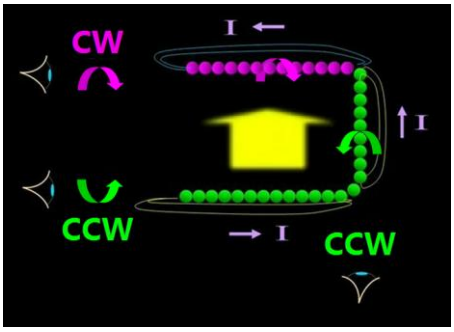


Fig. 15 Cross-section of a coil

The threads in this example swing CCW at the bottom (green atoms) and CW at the top (violet atoms). Predictably, all the threads push through the center of the coil (yellow arrows) consistent with experience.

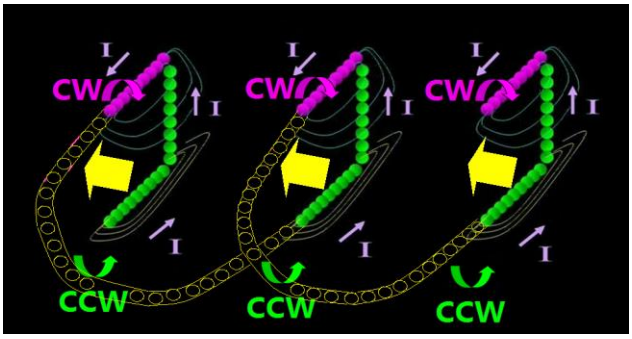


Fig. 16 A magnet has the same field and force patterns as a coil. In this example, the lines of force on the top half of the magnet flow CCW and in opposite direction to the field at the bottom half which flow CW.

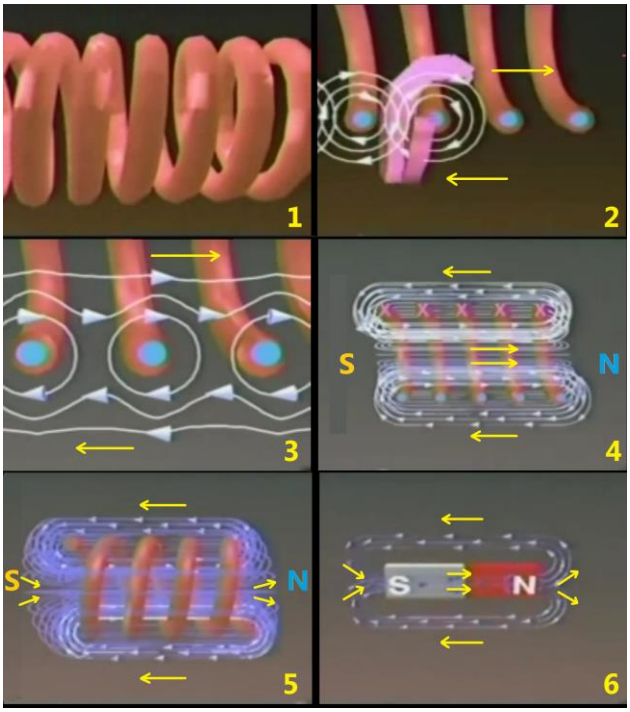
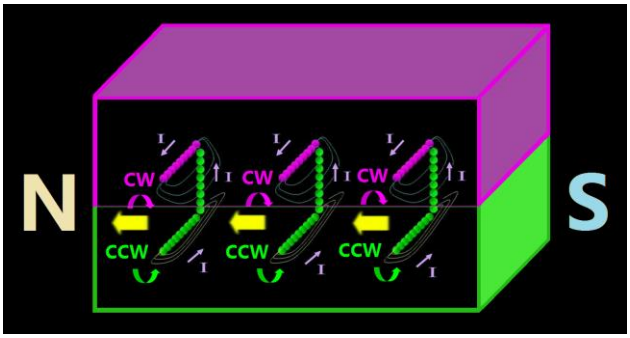


Fig. 17 Coil superimposed on a magnet

CW (top) and CCW (bottom) swinging threads sweep through the center of the coil (yellow arrows) from right (S) to left (N).



XI. A MAGNETIC 'FIELD' IS DYNAMIC

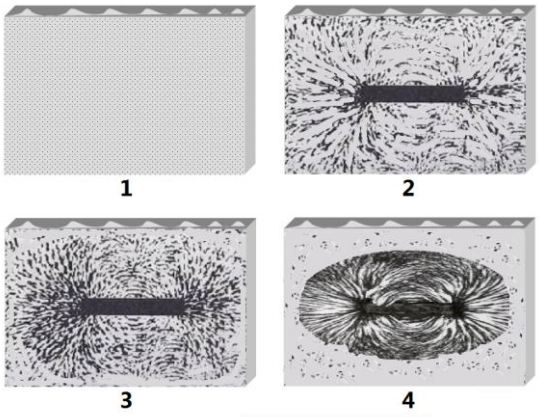
It is pertinent at this point to ask whether there is anything moving inside a magnetic field – specifically, the lines of force that comprise it – because the Theory of Threads rests entirely upon this assumption. If there is no motion inside the region known as 'magnetic field' Thread Theory suffers a sudden death.

Are Faraday's lines merely standing still whilst the iron filings align along their extent and just sit there? What makes the question valid and intriguing is that, once the iron filings are drawn in and contribute to the pile of metallic ruble around the magnet, they no longer move. Adding to the confusion is the term *static magnetic field* used extensively in the discipline to refer to the constancy of magnetic intensity. The adjective *static* alludes to the fact that the intensity does not vary with time.

We first mention that Faraday, who had an intimate relation with magnets for 40 years in his lab, had convinced himself that the lines are real. [9] We add that although Maxwell was skeptical, he clarified in his definition of the term *magnetic field* that "*in that space there is matter in motion"*. [28] Of course, we are not going to rely on their authority. This is just a reminder that those who initially studied magnetic fields in detail and came up with the laws that most people simply memorize today were convinced that there was something real moving in the region known as 'magnetic field'.

For those who still harbor doubts, it is well-established that magnetic fields collect iron filings *gradually*, one by one. We introduce a bar magnet in a tank of water that has iron filings distributed throughout its volume more or less uniformly. The iron filings will *gradually* be collected one by one by the sweeping magnetic field over the next couple of minutes and attach to the magnet (*Fig. 18*). This can only be explained with 'matter in motion' as hinted by Maxwell.

Fig. 18 1. Iron filings are swirled in water until the mix is more or less uniform. 2. We introduce a magnet and the iron filings spontaneously begin to travel toward it. 3. More filings are gathered over time around the magnet. 4. The filings end up encapsulating the magnet. This shows that Maxwell's characterization – 'matter in motion' – is a fitting description for what is happening in the region heretofore known as 'magnetic field'. A physicist is tasked with identifying what that something is.



Under the Rope Hypothesis, the phenomenon just described suggests that the 'matter' that constitutes and is moving inside a magnetic field are EM threads. It is these swinging threads that have the power to influence matter. The skeptic has to answer in the alternative what it is that is moving in the region around a magnet that has the power to collect iron filings one by one over time.

XII. FLOW OF THREADS IN A MAGNET

What would we see in the region between two magnets if we stopped all motion in the Universe and had the eyes of God? What object is moving in the field region surrounding a magnet? And if we hypothesize that the lines are physical threads – as opposed to inexistent mathematical lines – how do these threads produce attraction and repulsion between magnets?

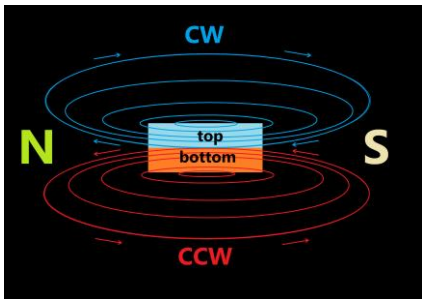
We argue that we would see what we have already partially illustrated earlier when we explained attraction and repulsion between parallel wires (*Fig. 12*). We would see countless physical threads. More accurately, we would see layers upon layers of walls of threads, one right behind the other. These threads do not stand still waiting for the shards to sit on them as would seem to be suggested by the inert lines formed by visible, motionless metal powder. The threads sweep around the magnet, swinging constantly around by rapidly spinning atoms aligned in rows we call *serpentines*. These threads seep through the iron filings like fish through water, magnetizing them in the process through

an imperceptible friction that aligns their individual domains in the same CW or CCW direction.

In *Fig. 19* we illustrate the direction in which orthodoxy has traditionally depicted magnetic fields in magnets: CW on the top and CCW on the bottom half when the magnet is facing north–south viewed from left to right. 'Lines of force' *enter* the south side and *exit* the north end.

Fig. 19 Conventional flow of magnetic lines

The orthodox view is that a magnet is divided into north and south ends, and that inexistent, abstract lines comprise the magnetic field.



Figs. 20 and 21 illustrate what is occurring under the Rope Hypothesis. The atoms comprising the magnet spin and sweep countless walls of threads around the magnet. It is these threads that enter one end of the magnet and exit the other. A magnet is not divided into north and south or positive and negative ends. A magnet is divided into top and bottom halves. The traditional north - south view is actually a side view parallel to the rows of atoms that are swinging threads around the magnet.

Fig. 20 Thread Theory proposes that interconnected atoms form rows known as serpentines. The serpentines spin and swing countless walls of EM threads around the magnet. It is these physical threads which form what the mathematical world has identified as 'magnetic fields'. A magnet is not divided into (north – south) or (positive – negative) poles. A magnet is divided into top and bottom regions, with top threads swinging in opposite direction to bottom threads.

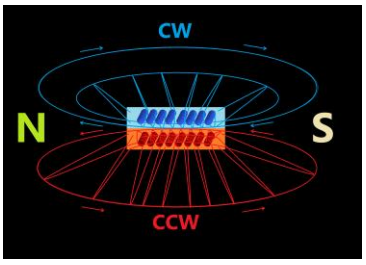
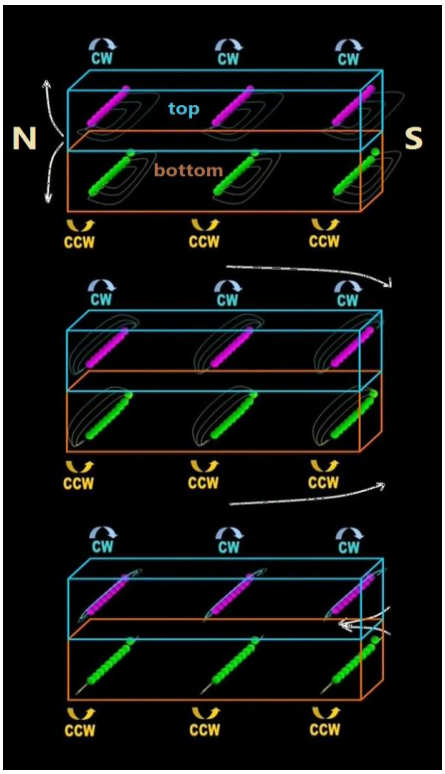


Fig. 21 Threads flow through and around a magnet

Threads are depicted sideways in the illustrations. The threads squeeze through the top-bottom interface and sweep from south to north



XIII. ATTRACTION

A magnet attracts another exactly as two wires do and like we explained in Section VIII and illustrated in *Fig. 12A*. In *Fig. 22* we see two magnets facing in the traditional north-south direction. Under the Rope Model, the threads enter the south side of each magnet and exit their north ends. As a reference, on the right bottom side of the drawing is a picture of the pattern left by iron filings sprinkled around two wires which have their 'currents running' in the same direction.

a. Left magnet, bottom right-hand corner. The threads are swinging upwards (CCW - green) and interlock with the threads swinging downwards (CCW - green) in the bottom, left-hand corner of the magnet on the right.

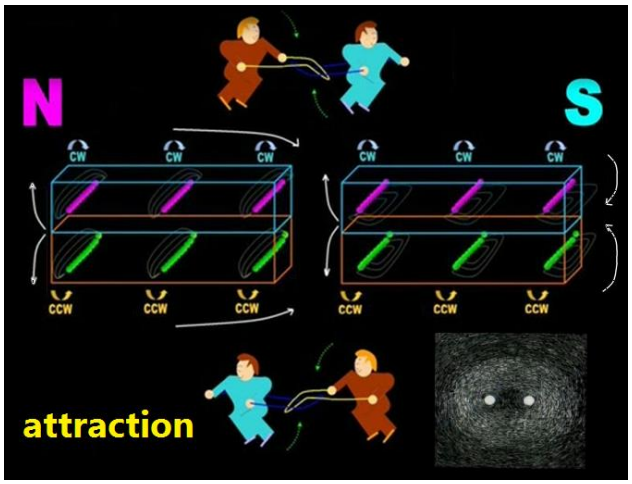
b. Left magnet, top right-hand corner. The threads are swinging downwards (CW - violet) and interlock with the threads swinging upwards (CW - violet) in the top, left-hand corner of the magnet on the right.

Note that if we turn one of the magnets 180 degrees in the top – down direction, nothing changes. This is consistent

with experience. For instance, if we turn the magnet on the right upside down, switching green serpentines with violet ones, the bottom (green) serpentines no longer spin CCW, but now spin CW and the top (violet) serpentines no longer spin CW, but now spin CCW.

The closer one magnet is to another, the more threads that intervene in the entire process and the stronger the pull. This is consistent with the well-established square of the distance rule.

Fig. 22 The physical mechanism of attraction between two magnets



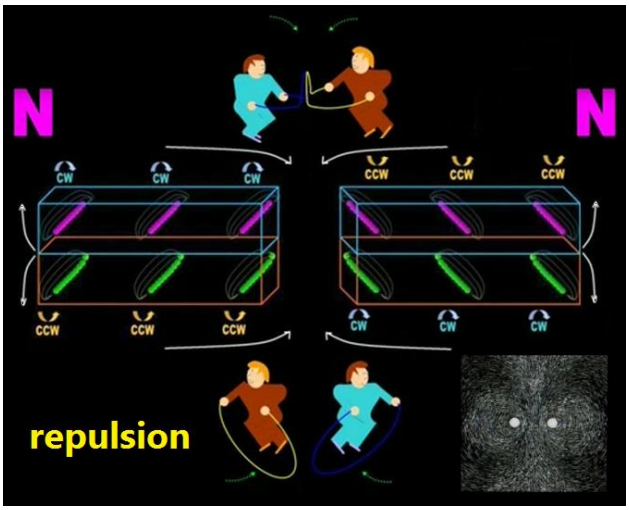
XIV. Repulsion

If we turn the right magnet 180 degrees in the traditional north – south direction, its top serpentines (violet) no longer spin CW, but rather CCW and the bottom serpentines (green) no longer spin CCW, but rather CW. These behaviors are illustrated in *Fig. 23* together with a picture of the pattern left by iron filings sprinkled over two wires which have their 'currents flowing' in opposite directions.

The mechanical effect is that the threads in the top regions of both magnets collide and push the magnets away from each other. Likewise, the threads in the bottom regions of both magnets collide and push the magnets away as well. The farther the magnets are from each other, the fewer threads that intervene in the process and the weaker the repulsion consistent with experience.

If we overturn the magnet upside down in the top – down direction, things remain the same. The earlier bottom threads (green) were spinning CW and now spin CCW, and the top threads (violet) were spinning CCW and now spin CW.

Fig. 23 The physical mechanism of repulsion between two magnets



XV. Why a monopole cannot be isolated

Dirac speculated that a magnet known as a *monopole* can exist without a north pole or without a south pole. [35] The Wikipedia defines a *monopole* as:

> *"a hypothetical elementary particle in particle physics that is an isolated magnet with only one magnetic pole (a north pole without a south pole or vice versa)".* [36]

The article adds that the grand unified and superstring theories predict their existence. In spite of this bold claim and after investigating monopoles for over 80 years, researchers have yet to discover or produce a monopole. [37] [38] The Particle Data Group at the Lawrence Berkeley National Laboratory reported that as of 2015 no monopoles of any kind have been discovered. [39] [40]

Let's concede the existence of the monopole predicted by Dirac, Quantum Mechanics, and String Theory for the sake of argument. We illustrate this hypothetical particle in *Fig. 24*. How does this discrete unit pull on another from a distance? By what physical mechanism?

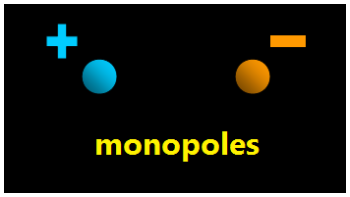
Under the Rope Model, the reason a monopole cannot be isolated is readily apparent. If we chop up a magnet until there is a single row of atoms, we would still have a top row of atoms swinging the threads CW and a bottom row swinging them CCW. We need both to create attraction or repulsion.

Let's illustrate this mechanism. In *Fig. 25* we have the image of two atoms forming the top and two atoms forming the bottom of our basic magnet. The top row is swinging the threads CW and the bottom serpentine swings them CCW. We have south and north poles. We can't reduce the system

further because there must be an EM rope binding two atoms for there to be at least one thread swinging around the other. The thread that is swinging still enters in one direction (S) and exits in the other (N). Anything less than that implies that we have no rope at all. There is no magnetism in a universe consisting of a single atom!

Fig. 24 Dirac's monopole

Quantum Mechanics and String Theory predict the existence of a particle that is a magnet but lacks either a north pole or a south pole. It is a single pole magnet known as a monopole. Let's concede this proposal. How does a discrete, positive monopole particle pull on another negative one from a distance? What will the theorist fill the space between them with?Or is there perchance something pushing them together from the outside?



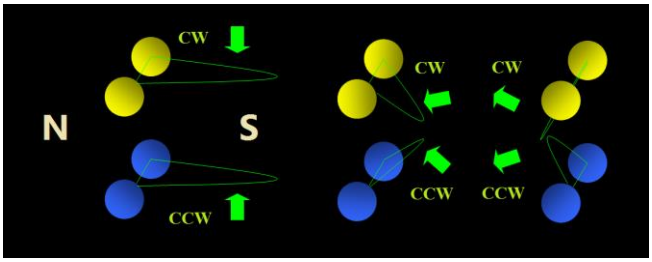
XVI. Conclusions

We pick up where Faraday left off over 150 years ago. If most of the relevant references at the end of this paper are dated to the 19th Century it is because no one has analyzed the physical nature of lines of force or of the magnetic field with the same enthusiasm, care, and intensity since then. The entire issue has been swept under the rug and deemed settled. Not a single university, research center, or lab anywhere on Earth is investigating the physical nature underlying the magical properties of magnetic fields. The mantra that everyone is required to repeat in high school and in college is simply that north attracts south.

If as Faraday opined lines of force are real and if as Maxwell opined there is exotic matter moving in the region mathematicians call 'magnetic field', the Rope Hypothesis rises to the challenge and proposes that swinging electro-magnetic threads simulate not only the halo along which iron filings align, but the activity that brings two magnets together. The skeptic has the burden of identifying what is in that region in the alternative. Of course, if threads scan the region around a magnet, all of the explanations provided by Quantum Mechanics since inception involving discrete particles as well as the entire Standard Model of Particle Physics [41] suffer a sudden death and get dumped in the ash heap of history.

Fig. 25 Why a monopole cannot isolated

We have a minimum system to produce magnetism. There are two atoms on the top (yellow) spinning CW and two atoms on the bottom (blue) spinning the thread CCW. The two threads go through the center from south to north. We could reduce the system further two two atoms and still have the single thread travel from right (S) to left (N). If we reduce the system further to a single atom we have no rope at all. A single atom universe has no magnetism.



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"Heat, therefore, may pass out of one body into another just as water may be poured from one vessel into another, and it may be retained in a body for any time, just as water may be kept in a vessel. We have therefore a right to speak of heat as of a measurable quantity, and to treat it mathematically like other measurable quantities so long as it continues to exist as heat. We shall find, however, that we have no right to treat heat as a substance, for it may be transformed into something which is not heat, and is certainly not a substance at all, namely, mechanical work.

We must remember, therefore, that though we admit heat to the title of a measurable quantity, we must not give it rank as a substance, but must hold our minds in suspense till we have further evidence as to the nature of heat.

Such evidence is furnished by experiments on friction, in which mechanical work, instead of being transmitted from one part of a machine to another, is apparently lost, while at the same time, and in the same place, heat is generated, the amount of heat being in an exact proportion to the amount of work lost. We have, therefore, reason to believe that heat is of the same nature as mechanical work, that is, it is one of the forms of Energy."

[2] B. Gaede, *What is Physics?*, Science **341** (2014) 101 - 113

[3] T. Wilson, *How Magnets Work*, How Stuff Works, April 2, 2007.

> *"In magnets… most or all of the magnetic domains point in the same direction… the microscopic magnetic fields combine to create one large magnetic field… The more domains point in the same direction, the stronger the overall field. Each domain's magnetic field extends from its north pole into the south pole of the domain ahead of it. In a magnet, most or all of the domains point in the same direction. This explains why breaking a magnet in half creates two smaller magnets with north and south poles. It also explains why opposite poles attract -- the field lines leave the north pole of one magnet and naturally enter the south pole of another, essentially creating one larger magnet. Like poles repel each other because their lines of force are traveling in opposite directions, clashing with each other rather than moving together."*

[4] P. Peregrinus, *On the Magnet* (1269)

> *"WHY THE NORTH POLE OF ONE LODESTONE ATTRACTS THE SOUTH POLE OF ANOTHER AND VICE VERSA"*
>
> *"AS already stated, the north pole of one lodestone attracts the south pole of another and conversely; in this case the virtue of the stronger becomes active, whilst that of the weaker becomes obedient or passive. I consider the following to be the cause of this phenomenon: the active agent requires a passive subject, not merely to be joined to it, but also to be united with it so that the two make but one by nature. In the case of this wonderful lodestone this may be shown in the following manner: Take a lodestone which you may call A Z), in which A is the north pole and D the south; cut this stone into two parts, so that you may have two distinct stones; place the stone having the pole A so that it may float on water and you will observe that A turns towards the north as before; the breaking did not destroy the properties of the parts of the stone, since it is homogeneous; hence it follows that the part of the stone at the point of fracture, which may be marked B, must be a south pole; this broken part of which we are now speaking may be called A B. The other, which contains Z), should then be placed so as to float on water, when you will see D point towards the south because it is a south pole ; but the other end at the point of fracture, lettered C, will be a north pole; this stone may now be named C D. If we consider the first stone as the active agent, then the second, or C Z), will be the passive subject. You will also notice that the ends of the two stones which before their separation were together, after breaking will become one a north pole and the other a south pole. If now these same broken portions are brought near each other, one will attract the other, so that they will again be joined at the points B and C, where the fracture occurred. Thus, by natural instinct, one single stone will be formed as before."*

[5] W. Gilbert, *On the Loadstone and Magnetic Bodies and on the Great Magnet the Earth*, (1600), trans. P. Fleury Mottelay, Bernard Quaritch, London (1893)

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[12] *D. Jones*, *Lines of Force*, Navy Electricity and Electronics Training Series (NEETS), Module 01 – Introduction to Matter, Energy, and Direct Current (1998) p. 1-20

[13] T. Wilson, *How magnets work*, How Stuff Works (2007)

[14] L. Galvani, *Commentary On The Effect Of Electricity On Muscular Motion* (1791), trans. E. Licht, Cambridge, Massachusetts (1953)

> *"all access was cut off from the electric current… we saw no contractions ensue when a spark was produced… as if the conductor B, Fig. 3 were not attached to conductor EE at point C, but were suspended in a silk sling D; a new and indubitable demonstration that electricity flows through such conductors… electricity hastening through the nerves either from the muscles or from other parts to the cerebrum and rushing into it"*

[15] H. Oersted, *Experiments on the Effect of a Current of Electricity on the Magnetic Needle*, Annals of Philosophy **16** (1820) 273 – 277

> *"The electric conflict acts only on the magnetic particles of matter. All non-magnetic bodies appear penetrable by the electric conflict, while magnetic bodies, or rather their magnetic particles, resist the passage of this conflict…negative electricity moves in a spiral line bent towards the right…"*

[16] J. Biot, F. Savart, *Note sur le magnétisme de la pile de Volta*, Annales de Chemie et de Physique **15** (1820) 222 – 223, trans. into Portuguese by A. Assis & J. Chaib in Cadernos de História e Filosofia da Ciência, Campinas **16**(3)(2) (2006), 307 - 309

> *"The nature of the action is the same as that of a magnetized needle which is placed on the contour of a wire in a certain constant direction in relation to the direction of the current…"*

[17] J. Biot, *On the magnetization of metals by electricity in motion*, Journal des Savants (1821) p. 225, in *Ampere's Electrodynamics*, A. Assis, J. Chaib, Apeiron, Montreal, Canada (2015) p. 207

> *"the electric current… flows along metal bodies…"*

[18] A. Ampere, *Memoir on the Mathematical Theory of Electro-dynamic Phenomena, Uniquely Deduced from Experience* (1827), trans. by A. Assis & J. Chaib in *Ampere's Electrodynamics*, Apeiron (20150 285 – 320

> *"I will call the first effect electric tension and the other electric current… The second effect… occurs when these bodies form part of a circuit of conducting bodies… this last [electromotive] force… carries once more the positive electricity towards one side and the negative electricity towards the other side… two bodies… between which the electromotive action takes place are in communication by conducting bodies"*
>
> *"the electrical particles in the conducting wires, set in motion by the influence of the battery, continually change their position… the influences which each particle exerts… the alignments of the two elements, along which the electrical particles move" p. 299 (424)*

[19] M. Faraday, *Experimental researches in electricity*, Vol II, reprinted from Philosophical Transactions of 1838-1843, Richard and John Edward Taylor, London (1844) p. 25, § 1813

> *"the application of the spirit-lamp to the junction of these metals produced a thermo current which instantly travelled round the circuit"*

[20] W. Weber, *On the measurement of electro-dynamic forces*, Annalen der Physik und Chemie **73**(2) (1848) 193 – 240, in R. Taylor, ed./trans., Scientific Memoirs, selected from the Transactions of Foreign Academies of Science and Learned Societies, Vol. V, part 20, article 14, Taylor and Francis, London (1852).

> *"it is known that the electrodynamic forces which are produced with the strongest imaginable galvanic current in a simple wire, like the section of the arc BB' with current flowing through it…"*

[21] W. Thomson, *On Vortex Atoms*, Proceedings of the Royal Society of Edinburgh **6** (1867) 94-105.

> *"the strength of the electric current in the electromagnet, corresponding to an infinitely thin vortex core, remains constant, however much its length may be altered in the course of the transformations which it experiences by the motion of the fluid."*

[22] J. Maxwell, *A Treatise on Electricity and Magnetism*, Vol. 1, MacMillan, London (1873), p. 338

> *"At any point let an element of area dS be taken normal to the axis of x, and let Q units of electricity pass across this area from the negative to the positive side in unit of time, then, if Q/dS becomes ultimately equal to u when dSis indefinitely diminished, u is said to be the Component of the electric current in the direction of x at the given point."*

[23] A. Duffy, A. Loewy, *Forces on currents in magnetic fields*, Boston University (1999)

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[29] *What are magnetic fields?*, Khan Academy (2014)

[30] R. Feynman, *Fun to Imagine| 4: Stretching, Pulling and Pushing*, BBC (15 July 1983)

> *"I am not going to be able to give you an answer to why magnets attract each other except to tell you that they do… I don't understand it in terms of anything else that you're more familiar with."*

[31] B. Gaede, *Why God Doesn't Exist*, ViNi, Frankfurt (1998)

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